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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Joseph Hummel

Serial No.: 08/424,223

Filed: April 19, 1995

Title: KNITTABLE YARN AND SAFETY APPAREL

Docket No.: 10-142C3

Watts, Hoffmann, Fisher &  
Heinke Co., L.P.A.  
PO Box 99839  
Cleveland, Ohio 44119-0839

Assistant Commissioner for Patents  
Washington, D. C. 20231

RULE 132 DECLARATION

Dear Sir:

Now comes Joseph Hummel, the above-named applicant,  
who states as follows:

1. I am the applicant in the above-identified application.
2. The normal strength liquid crystal polymer having a tenacity of no more than ten grams per denier disclosed in the above-identified application was at the time of my invention made and sold by Hoechst Celanese Corporation (HCC) under the trademark Vectran M.
3. The composition of Vectran M was asserted to be a trade secret, and hence not available to me or the general public.
4. Vectran fiber is described by HCC as a high performance thermoplastic multifilament yarn spun from Hoechst Celanese Vectra liquid crystal polymer and is

stated to be the only commercially available melt spun liquid crystal polymer fiber in the world. See HCC brochure "Vectran Liquid Crystal Polymer Fiber," Exhibit A hereto, copyrighted 1990. Exhibit A states that "This new fiber is available in a family of product forms: Vectran HS, a high-strength reinforcement fiber; Vectran M, a high-performance matrix fiber; plus engineered commingled combinations...." Exhibit A states that the properties of Vectran fiber are distinguished from other high performance properties, which makes it the material of choice in demanding applications where other fibers fail to meet performance requirements. Exhibit A further states that "Vectran M fiber is a high modulus thermoplastic matrix fiber for applications requiring high impermeability, excellent property retention over a broad temperature range, and low moisture absorption."

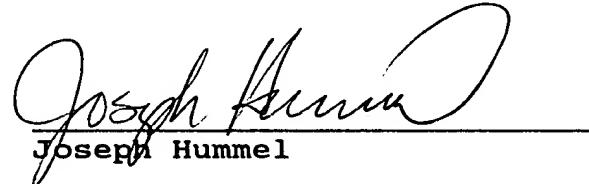
5. At the time of my invention and also at the present time, the cost to a purchaser of Vectran M was and is approximately 10 to 12 times the cost of polyester or nylon fiber of the same denier, commonly used for overwraps of core strands in composite cut-resistant yarns where the purpose is to provide bulk and/or comfort and knittability. Vectran M has a significantly greater tensile modulus than polyester or nylon, and therefore is disadvantageously a stiffer fiber if used merely for the purposes of bulk, comfort and/or knittability of a composite yarn, in place of nylon or polyester overwraps.

6. I am familiar with the Bettcher patent No. 4,470,251, having worked for Bettcher Industries during the development and manufacture of the yarn and glove disclosed in that patent. It is my opinion, based on over 15 years of industry experience in the designing and manufacturing of cut-resistant yarns, that one of ordinary skill in the art would not, at the time of my invention, or today, substitute Vectran M for nylon or

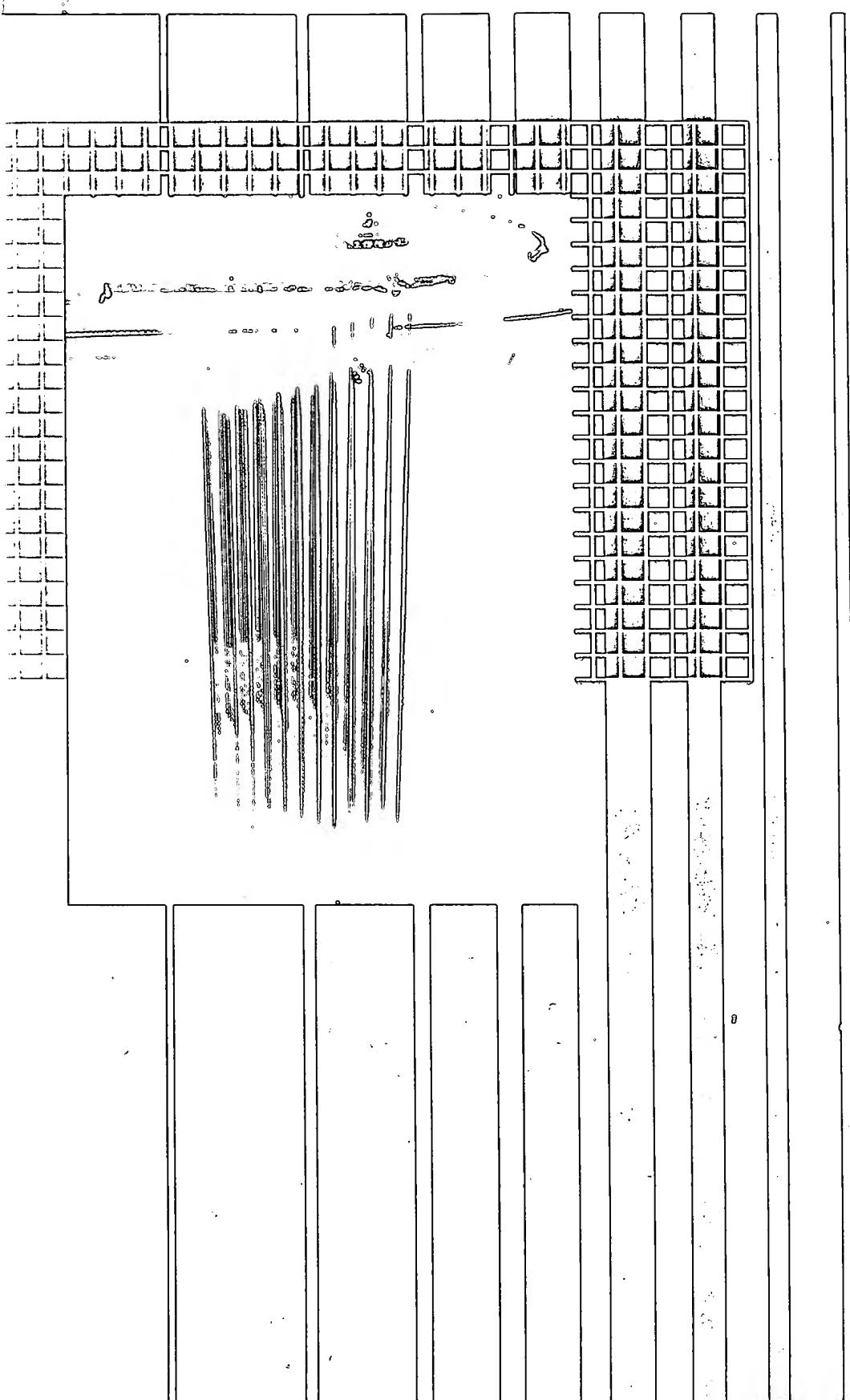
Polyester as core overwraps in cut-resistant composite yarns for the purpose of the nylon or polyester overwraps shown and described in the Bettcher patent 4,470,251, because of the facts set forth above in paragraph 5 hereof.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this application or any patent issued thereon.

Dated: Dec. 20, 2000

  
Joseph Hummel  
Joseph Hummel

**Vectran®**  
Liquid Crystal Polymer Fiber



**Vectran®  
Liquid Crystal  
Polymer Fiber:**

**A Unique  
Combination of  
Properties -  
For Demanding  
Applications**

## Hoechst Celanese

Hoechst Celanese, a subsidiary of Hoechst AG of West Germany, is a Fortune 100 corporation with leading positions in chemicals, fibers and film, advanced materials, and life sciences. Hoechst AG and its affiliates constitute the Hoechst Group, one of the world's largest multinationals, comprising 170,000 employees working in 250 companies in 120 nations. Hoechst Celanese customers benefit from our pursuit of quality, attention to basic research, and commitment to problem-solving that characterizes the Hoechst approach to business everywhere. More than 15,000 people in 14 nations are engaged in global research and development at Hoechst, funded by an annual budget on the order of \$1 billion.

This continuing research has resulted in another breakthrough in liquid crystal polymer technology...**Vectran** fiber.

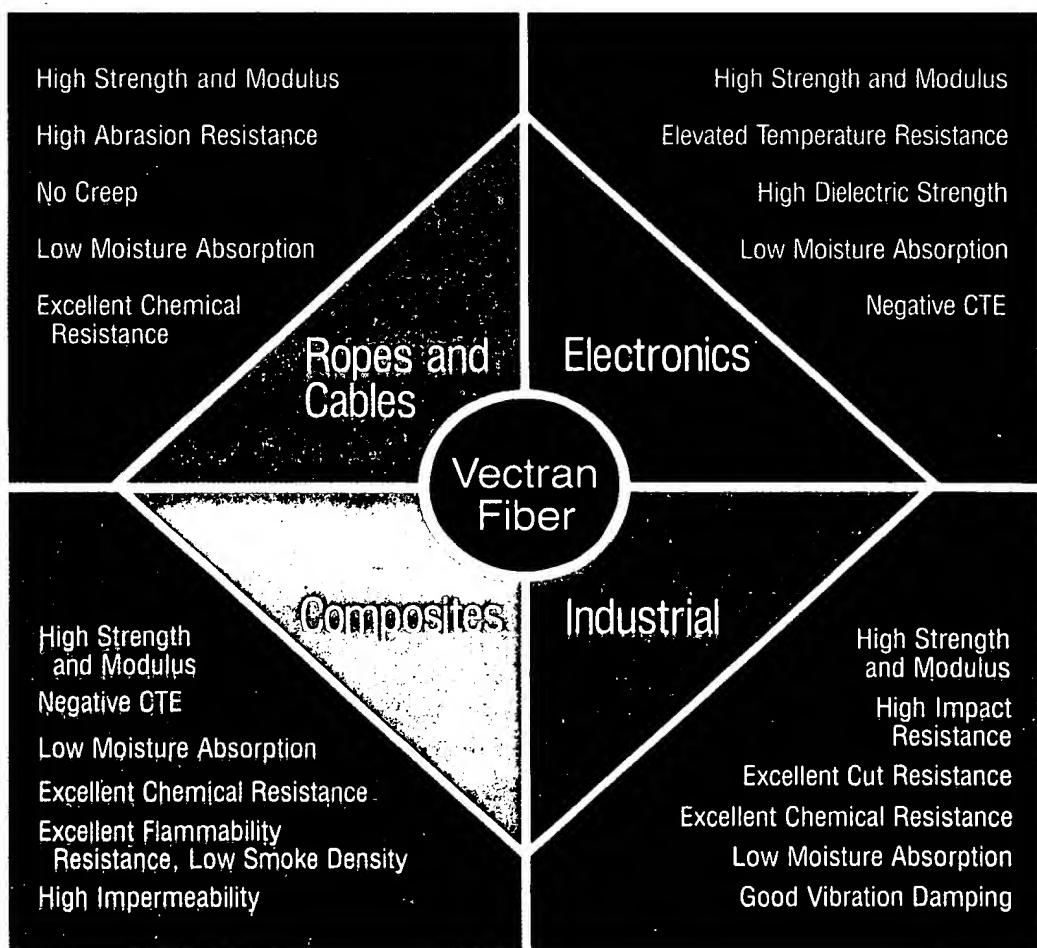
### **Vectran® Liquid Crystal Polymer Fiber:** A Unique Combination of Properties

Vectran fiber is a high-performance thermoplastic multifilament yarn spun from Hoechst Celanese Vectra® liquid crystal polymer (LCP), and is the only commercially available melt spun LCP fiber in the world. Vectran fiber exhibits exceptional strength and rigidity. Pound for pound Vectran fiber is five times stronger than steel and ten times stronger than aluminum. It is characterized by a unique combination of beneficial properties: high strength, no creep (when tested to 50% of breaking load), low moisture absorption, negative coefficient of thermal expansion (CTE), good property retention over a broad temperature range, and extraordinary chemical resistance. The result of more than 15

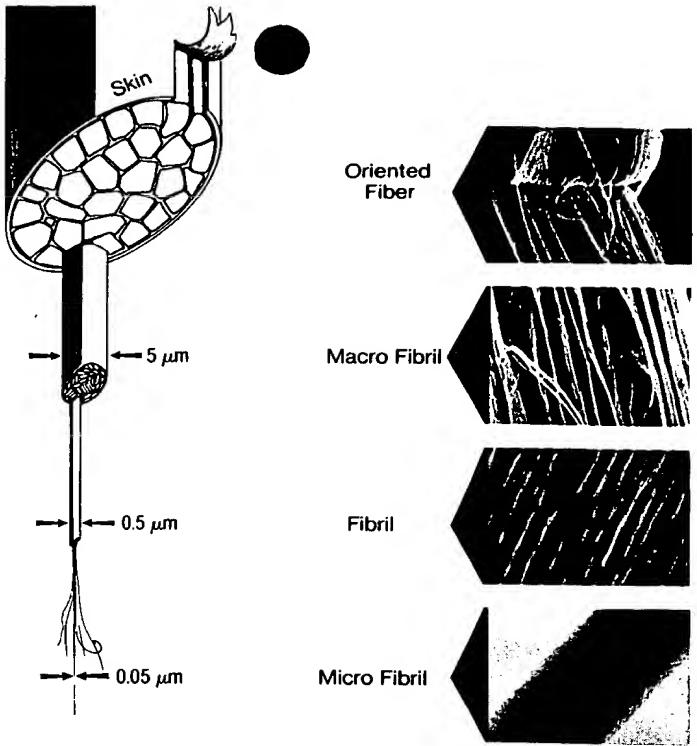
years of dedicated research and development by Hoechst Celanese scientists and the establishment of over 131 LCP-related U.S. patents, Vectran fiber provides engineers with never before available options in material selection. This new fiber is available in a family of product forms: Vectran HS, a high-strength reinforcement fiber; Vectran M, a high-performance matrix fiber; plus engineered, commingled combinations of HS and M and of S-2 Glass® fiber and M.

### **Where Existing Materials Fail to Perform**

A unique combination of properties differentiates Vectran fiber from other high-performance fibers and makes it the material of choice in demanding applications where other fibers fail to meet performance requirements.



**Vectran Fiber Applications and Properties Chart**



### Vectran® Fiber Structural Model

## Ropes And Cables

*Vectran* HS is solving performance problems in critical marine, military, and industrial rope and cable applications. High strength with no creep allows manufacture of high performance ropes that are stable to extended loads. Superior abrasion resistance, excellent moisture resistance, and exceptional property retention over broad ranges of temperature and chemical environments, provide solutions to industrial wear and degradation problems experienced with existing fiber

products. When a balance of outstanding properties is needed, *Vectran* fiber is the answer. That's why the U.S. Navy is using *Vectran* HS fiber for a series of demanding, specialized applications.

## Electronics

*Vectra* LCP in polymer form is used world-wide in precision molded electronic products. The same LCP in *Vectran* HS fiber form is an excellent candidate for printed circuit boards, fiber optic strength members, and



Ropes with *Vectran* fiber cores.

conductor reinforcements. High dielectric strength coupled with elevated temperature resistance and outstanding moisture resistance provide new levels of electrical efficiency in prevention of current leakage. This combination along with excellent dimensional stability and low CTE provide a unique fiber for specialized electronic uses.

## Composites

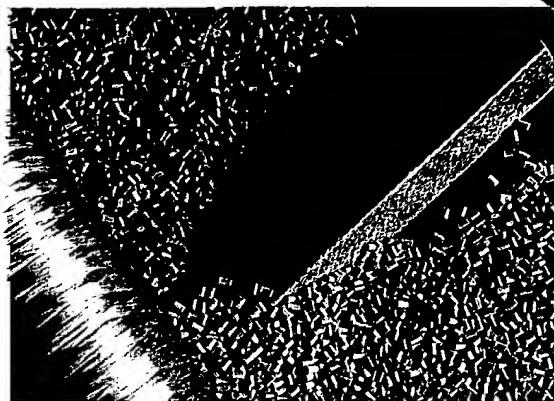
The *Vectran* fiber family is available in a range of deniers for textile and composite processing and offers new options in design and material selection.

*Vectran* HS fiber offers benefits for applications requiring high strength, vibration damping, low moisture absorption, and low CTE. *Vectran* M fiber is a high modulus thermoplastic matrix fiber for applications requiring high impermeability, excellent property retention over a broad temperature range, and low moisture absorption.

Commingled *Vectran* HS and *Vectran* M fibers are engineered to combine fiber reinforcement with an identical fiber matrix system. *Vectran* M fiber commingled with S-2 Glass® fiber provides a hybridized reinforcing system for precision fiber placement. Both products allow the manufacture of drapable forms for one-step, in-mold processing and cure of complex-shaped parts.

## Industrial

*Vectran* fiber brings unique solutions to industrial applications. Protective apparel benefit from *Vectran* fiber's excellent cut resistance, elevated temperature resistance, and durability to multiple wash/dry cycles. *Vectran* fiber reduces vibration



Polymer, fiber, and composite.

in sporting equipment, and its stability to most chemicals allows the manufacture of chemically resistant packings and gaskets. These and other applications have put Vectran fiber's problem-solving combination of properties to the test.

## APPLICATIONS

Antenna Guy Wires

Chemical Resistant Packings and Gaskets

Electro-Mechanical Reinforcements

Electro-Optical Reinforcements

Heat Resistant Belting

Printed Circuit Board Substrates

Protective Gloves

Sporting Equipment

Towing and Mooring Lines

## Product Forms

Available in continuous multifilament yarns, Vectran HS fiber is offered with or without a standard textile finish to assist in processing, or with an abrasion-resistant finish. Vectran M fiber is available with or without a standard textile finish. Commingled Vectran fibers contain no finish. In commingled Vectran M and S-2 Glass® fibers, only the glass fiber contains producer size.

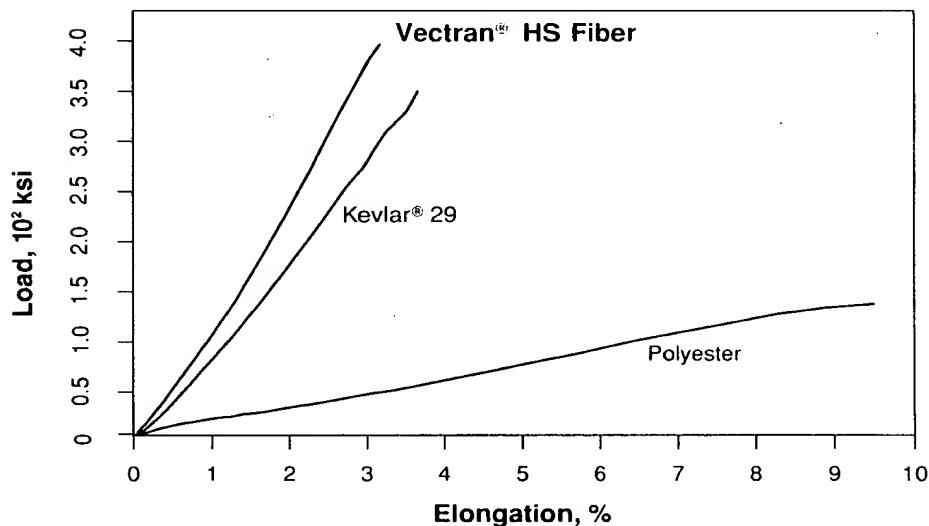
## Typical Properties of 1500/300 Vectran Fibers

	<b>Vectran HS</b>	<b>Vectran M</b>
Tensile Strength*	23 g/denier 412 ksi	9 g/denier 161 ksi
Tensile Modulus*	525 g/denier 9.4 MsI	425 g/denier 7.6 MsI
Elongation at Break*	3.3%	2.0%
Melting Point	330° C 625° F	276° C 529° F
Moisture Regain	<0.1%	<0.1%
Dielectric Constant @ 1 kHz **	3.3	3.3
Density	1.4 g/cm³ 0.05 lbs/in³	1.4 g/cm³ 0.05 lbs/in³
Chemical Resistance	Hydrolytically stable. Resistant to organic solvents. Stable to acids (<90% conc.). Stable to bases (<30% conc.)	

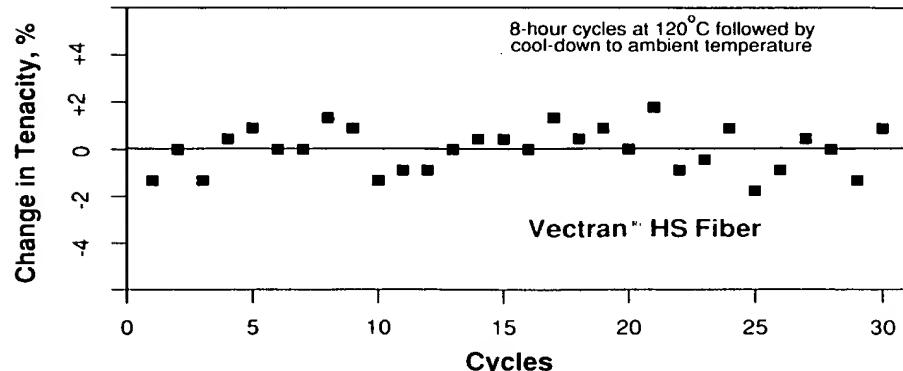
\* ASTM D885, 10 in. gauge length, 10% strain rate, 2.5 tpi twist

\*\*Measured on Vectra resin

## Stress-Strain Behavior of Fibers



## Tenacity Retention Versus Cycles At Temperature



## Vectran Fiber Product Line

### Vectran HS Fiber Products

<b>Denier</b>	<b>DPF</b>	<b>Filament Diameter, Microns</b>	<b>Filament Count</b>	<b>Yield, Yards/lb</b>
1500	5.0	23	300	3000
900	5.0	23	180	5000
750	5.0	23	150	6000
200	5.0	23	40	22300

### Vectran M Fiber Products

<b>Denier</b>	<b>DPF</b>	<b>Filament Diameter, Microns</b>	<b>Filament Count</b>	<b>Yield, Yards/lb</b>
1500	5.0	23	300	3000
900	5.0	23	180	5000
750	5.0	23	150	6000
200	5.0	23	40	22300
50	5.0	23	10	89400

### Commingled Vectran HS Fiber / Vectran M Fiber Products\*

<b>Denier</b>	<b>DPF</b>	<b>Filament Diameter, Microns</b>	<b>Filament Count</b>	<b>Yield, Yards/lb</b>	<b>Volume and Weight Percent, Vectran HS Fiber</b>
2400	5.0	23	480	1860	62.5
3000	5.0	23	600	1490	50.0

### Commingled S-2 Glass® Fiber / Vectran M Fiber Products\*\*

<b>Denier</b>	<b>Yards/lb</b>	<b>Volume Percent, S-2 Glass® Fiber</b>	<b>Weight Percent, S-2 Glass® Fiber</b>
8470	525	59	72
9070	490	53	67

\*Commingled Vectran fibers contain no finish.

\*\*S-2 Glass® fiber contains producer size.

For more information on *Vectran*  
fiber contact:

Business Manager, *Vectran* Fiber  
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Charlotte, NC 28232-2414  
1 800 235 2637  
FAX 704 554 3776

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